Treatment of Ulnar Impaction Syndrome with and without Central TFC Lesion

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Abstract

Background Arthroscopic debridement of the triangular fibrocartilage (TFC) is well accepted in patients with ulnar impaction syndrome with central TFC lesions. Treatment remains controversial, however, when there is no such lesion from radiocarpal view.

Purpose This study assessed the clinical outcome of arthroscopic central TFC resection and debridement and secondary ulnar shortening in patients with ulnar impaction with central TFC lesion compared with patients without TFC lesion.

Patients and Methods Thirty-two consecutive patients with ulnar impaction syndrome were arthroscopically treated, 16 of whom had a central lesion of the TFC that was debrided. In the 16 patients with no lesion from the radiocarpal view, the TFC was centrally resected and debrided to decompress the ulnocarpal joint. Persisting symptoms necessitated ulnar shortening in four patients in each group. Two patients underwent repeat arthroscopic TFC debridement. All patients were examined at 3, 6, and 12 months, and at final follow-up (mean: 1.7 years) following arthroscopy, respectively ulnar shortening or hardware removal.

Results In both groups, pain, Krimmer, and DASH scores significantly improved. Improvements of DASH scores were significantly higher in patients without lesion at 12 months and at final follow-up. For other parameters, no significant difference was found between the two groups.

Conclusion In both situations, with and without central TFC lesion, resection and debridement sufficiently reduced the ulnar-sided wrist pain and improved function in three out of four patients, and therefore qualified as the first-line treatment of ulnar impaction syndrome as arthroscopy is performed, anyway. Those patients who complained of persisting or recurrent ulnar-sided wrist pain finally benefitted from ulnar shortening osteotomy as the secondary procedure.

Level of Evidence Therapeutic III, case-control study.

Keywords

- ▶ triangular fibrocartilage
- ▶ ulnar impaction syndrome
- ▶ ulnar shortening osteotomy
- ▶ wafer resection
- ▶ wrist
- ▶ arthroscopy

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Ulnocarpal impaction syndrome is a degenerative condition resulting from the abutment of the distal end of the ulna or of the triangular fibrocartilage (TFC) against the ulnar carpus.¹ Palmer described the extent of degeneration, ranging from degenerative wear of the horizontal TFC portion without or with concomitant chondromalacia of the ulnar aspect of the lunate or radial aspect of the ulnar head or both. These conditions were classified as 2A and 2B lesions, respectively. Further progression leads to the perforation of the horizontal TFC portion and later to laxity or even disruption of the lunotriquetral ligament. Finally, chronic load may result in degenerative arthritis of the ulnocarpal, and occasionally, the distal radioulnar joint (DRUJ).² Arthroscopic debridement of the TFC is widely accepted for painful ulnar impaction syndrome with central perforations.^{3,4} The treatment of patients in whom the TFC appears to be intact from radiocarpal view, however, remains controversial. Thereby, we occasionally repeat arthroscopy for persisting ulnar-sided wrist pain after simple irrigation and synovectomy for a superficially intact TFC. Repeat arthroscopy sometimes reveals central TFC perforations that were not present at index procedures.^{5,6} Abe and Tominaga⁷ diagnosed isolated TFC tears and fibrillations within the DRUJ in two patients with ulnar impaction syndrome. They reported relieved pain and good functional recovery following arthroscopic TFC debridement. Based on these reports, in 2012, we began to treat patients with clinically diagnosed ulnar impaction syndrome using arthroscopic central TFC resection and debridement even if a central full-thickness TFC perforation was not present from the radiocarpal view (i.e., Palmer 2A and 2B lesions).

This article presents the clinical outcome of patients who underwent central TFC resection and debridement for a clinically diagnosed ulnar impaction syndrome with an isolated positive fovea sign. We supposed that an isolated TFC resection would effectively reduce ulnar-sided wrist pain, regardless of whether the TFC presented to be intact or not from the radiocarpal view.

Patients and Methods

From January 2012 to June 2015, 34 consecutive patients with ulnar-sided wrist pain due to ulnar impaction syndrome were treated in whom conservative treatment failed to sufficiently diminish symptoms. Patients with a previous history of fractures of the affected arm or wrist and those who underwent procedures, in addition to arthroscopic TFC debridement, were not included in this review. Among the patients who were suspected to have ulnar impaction syndrome, only those who presented with an isolated positive fovea sign, with no other pathological findings upon clinical examination, were followed by routine clinical follow-ups. The patients were preoperatively assessed for their pain level on a visual analog scale (VAS) regarding exertion and rest and for the range-of-motion and grip-strength of both the affected and contralateral wrists. The Krimmer⁸ and Disability of Arm, Shoulder, and Hand (DASH) scores were calculated. A radiographic examination included standard plain X-rays in the posterior-anterior (PA) and lateral view and the PA views of both wrists under axial load. Ulnar variance was determined using the perpendiculars.⁹ Arthro-

scopy was performed in a standardized fashion with the wrists thoroughly examined and documented as has been described in the literature.^{3,10} If arthroscopy revealed a central TFC perforation (►Fig. 1), the lesions' margins were first resected by the use of a punch (►Video 1) and then debrided using an oscillating shaver (►Video 2). Thereby, the ulnocarpal compartment was decompressed, and the lesions' margins were prevented from being pinched between the head of the ulna and the carpus. If arthroscopy revealed a superficially intact TFC with no other pathological findings that would explain the patient's symptoms, then ulnar impaction syndrome was still suspected according to the clinical examination. ►Videos 3 to 5 present such a patient (for the additional access to the DRUJ, this case was not included in this cohort of patients) with intact TFC from radiocarpal view (►Video 3) but with fibrillations and an incomplete tear solely within the DRUJ (►Video 4). In this patient, the TFC was perforated using the probe (►Video 5), and the TFC was then resected and debrided in the way described above. Additional resecting procedures to the ulnar head (as in a Wafer procedure) were not performed. ►Fig. 2 represents such a TFC that would be diagnosed as intact when viewed from radiocarpal, but that appeared thinned and weakened after it had been perforated by the probe. Preoperatively, the patients were extensively informed about this treatment regimen. They gave their consent knowing that this regimen was not generally accepted among experts. During TFC resection, the joints were irrigated using saline. Arthroscopy was followed by the intra-articular injection of cortisone and bupivacaine into the radiocarpal and midcarpal joint spaces. The patients received a short arm cast for 1 week and were asked to limit load for 2 additional weeks. Follow-up examinations included standard clinical assessments at 3, 6, and 12 months, respectively. Additional follow-ups were performed in patients who underwent ulnar shortening osteotomies (ulnar approach, 3.5-mm 7-hole plate placed palmarly; KLS Martin; Tuttlingen, Germany) or hardware removal thereafter, provided that symptoms persisted that long. Follow-up assessments were conducted in concordance with the ethical standards of the appropriate ethical committee. Furthermore, the ethical committee approved the

Fig. 1 Central perforation of the TFC. TFC, triangular fibrocartilage.

clinical review of this cohort of patients. Data of the patients included in this review have previously been used to answer further research questions.¹¹

Video 1

The patient in ►**Fig. 1**. Central resection of the TFC lesions' margins is performed using a punch. TFC, triangular fibrocartilage. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1607073.

Video 2

The patient in ►**Fig. 1** and ►**Video 1**. Debridement of the lesions' margins using an oscillating shaver. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1607073.

Video 3

A patient with ulnar-sided wrist pain with an isolated positive fovea sign. The TFC appears to be intact from the radiocarpal view. Centrally, there appears to be a weak spot without full-thickness perforation. TFC, triangular fibrocartilage. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1607073.

Video 4

The same patient as in ►**Video 3**. DRUJ arthroscopy reveals fibrillations and an incomplete tear solely within the DRUJ. DRUJ, distal radioulnar joint. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1607073.

Video 5

The same patient as in ►**Videos 3** and **4**. The TFC is being perforated and then centrally resected and debrided as shown in ►**Videos 1** and **2**. TFC, triangular fibrocartilage. Online content including video sequences viewable at: www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1607073.

Fig. 2 A TFC without central lesion as seen from radiocarpal view that appears thinned and weakened after it has been perforated by the probe. TFC, triangular fibrocartilage.

Statistical Methods

The patients without TFC perforation were compared with the patients with perforation with respect to their age (*t*-test), duration of symptoms until arthroscopy was performed (Mann–Whitney test), duration of working disability (Mann–Whitney test), ulnar variance (chi-square test), and affection of the dominant hand (chi-square test).

For pre- to postoperative comparisons, data were first examined for normal distribution using the Shapiro–Wilk test. The nonparametric Wilcoxon test was applied for pain on exertion and rest and for data on range-of-motions and the Krimmer and DASH scores. Data are presented as medians and interquartile ranges (IQRs). The parametric *t*-test was applied for comparison of grip strength with data presented as means and standard deviations (SDs).

Improvement of the variables, namely, pain, grip strength, and Krimmer and DASH scores at different follow-ups demonstrated normal distribution on the Shapiro–Wilk test. Comparisons were therefore performed using the *t*-test. Fisher's exact test was used to compare the patients' satisfaction at follow-ups and the number of consecutive operations in each group.

Results

Overall, 34 patients with isolated positive fovea sign were included. Of these, two patients were excluded for their arthroscopically diagnosed ulnar-sided TFC detachment (Palmer 1B lesion). Of the remaining 32 patients, 16 were arthroscopically diagnosed with a central TFC perforation, and 16 had no central perforation. The patients' data are listed in ►**Table 1**. The patients' age, duration of symptoms, and work disability did not differ between the two groups. Patients without central TFC perforation had their dominant hand significantly more often affected than patients with perforation, whereas patients with TFC perforation had

Table 1 Thirty-two patients with ulnar impaction syndrome who presented with an isolated positive fovea sign

	16 patients <i>without</i> central TFC perforation	16 patients <i>with</i> central TFC perforation	Comparison of the two groups
Age (y)	32 (range, 18–55)	36 (range, 18–60)	$p = 0.326$
Affected wrist	11 right/5 left	4 right/12 left	–
Affected wrist is dominant wrist	12 yes/4 no	6 yes/12 no	$p = 0.033$
Duration of symptoms (mo)	8.9 (range, 1–36)	9.4 (range, 1–24)	$p = 0.649$
Symptoms related to work disability (wk)	1.6 (range, 0–8)	2.4 (range, 0–8)	$p = 0.739$
Ulnar variance	mean + 0.44 mm 1 × – 1 mm 8 × ± 0 mm 6 × + 1 mm 1 × + 2 mm	mean + 1.4 mm 5 × ± 0 mm 3 × + 1 mm 4 × + 2 mm 4 × + 3 mm	$p = 0.014$
Additional arthroscopic findings	1 × lunotriquetral ligament attenuation 6 × synovitis at ulnocarpal joint 2 × chondromalacia at tip of hamate	1 × lunotriquetral ligament attenuation 4 × synovitis at ulnocarpal joint	–

Abbreviation: TFC, triangular fibrocartilage.

Table 2 Results for 16 patients *without* central TFC perforation following simple central TFC resection and debridement, consecutive ulnar shortening, or hardware removal

	Preop <i>N</i> = 16	3 mo postop <i>N</i> = 16	6 mo postop <i>N</i> = 15	12 mo postop <i>N</i> = 15	Final follow-up mean (1.7 y) <i>N</i> = 16
Pain on exertion (VAS)	7.8 (IQR: 1.75)	2.5 (IQR: 6.5) $p = 0.001$	2.0 (IQR: 4.5) $p = 0.001$	2.0 (IQR: 6.0) $p = 0.001$	1.8 (IQR: 2.8) $p = 0.001$
Pain on rest (VAS)	3.3 (IQR: 6.3)	0.0 (IQR: 0.8) $p = 0.002$	0.0 (IQR: 1.4) $p = 0.003$	0.0 (IQR: 0.0) $p = 0.003$	0.0 (IQR: 0.0) $p = 0.002$
Grip-strength compared with contralateral hand	88% (SD: 33)	98% (SD: 22) $p = 0.056$	95% (SD: 17) $p = 0.070$	98% (SD: 15) $p = 0.017$	102% (SD: 17) $p = 0.098$
Extension (degrees)	60 (IQR: 10)	60 (IQR: 10) $p = 0.555$	60 (IQR: 10) $p = 0.974$	70 (IQR: 20) $p = 0.081$	70 (IQR: 15) $p = 0.017$
Flexion (degrees)	70 (ICR: 24)	75 (SD: 23) $p = 0.586$	80 (IQR: 25) $p = 0.073$	80 (IQR: 10) $p = 0.267$	78 (IQR: 14) $p = 0.090$
Radial abduction (degrees)	30 (IQR: 4)	30 (IQR: 9) $p = 0.305$	30 (IQR: 10) $p = 0.357$	30 (IQR: 15) $p = 1.000$	30 (IQR: 9) $p = 0.763$
Ulnar abduction (degrees)	30 (IQR: 10)	30 (IQR: 0) $p = 0.100$	30 (IQR: 5) $p = 0.282$	30 (IQR: 5) $p = 0.066$	33 (IQR: 5) $p = 0.028$
Pronation (degrees)	80 (ICR: 18)	80 (IQR: 0) $p = 0.527$	80 (IQR: 5) $p = 0.235$	80 (IQR: 10) $p = 0.873$	80 (IQR: 8) $p = 1.000$
Supination (degrees)	90 (IQR: 18)	90 (IQR: 10) $p = 0.206$	90 (IQR: 10) $p = 0.348$	90 (IQR: 10) $p = 0.121$	90 (IQR: 10) $p = 0.121$
Krimmer score	75.8 (IQR: 23)	85.0 (IQR: 16) $p = 0.003$	85.0 (IQR: 10) $p = 0.001$	85.0 (IQR: 15) $p = 0.001$	92.5 (IQR: 15) $p = 0.001$
DASH score	44.6 (IQR: 29)	13.3 (IQR: 27) $p = 0.001$	9.2 (IQR: 18) $p = 0.001$	10.0 (IQR: 14) $p = 0.001$	8.8 (IQR: 12) $p = 0.000$
Satisfied (Yes/No)	–	13/3	14/1	14/1	15/1

Abbreviations: DASH, disability of arm, shoulder, and hand questionnaire; IQR, interquartile range; postop, postoperative; preop, preoperative; SD, standard deviation; TFC, triangular fibrocartilage; VAS, visual analog scale.

Note: Results displayed in median and IQR or in mean and SD.

significantly longer ulnas compared with patients without perforation.

Among the 16 patients without central TFC perforation at the time of arthroscopy, 5 patients underwent further procedures for persistent or recurring ulnar-sided wrist pain. Ulnar shortenings were conducted in four patients at 5, 10, 12, and 16 months following arthroscopy. Of these patients, one 21-year-old patient complained of persistent discomfort at the ulnocarpal joint and along the site of the plate. She underwent hardware removal 15 months after ulnar shortening. Simultaneously, the central TFC defect was arthroscopically reevaluated. The regenerated TFC was redebrided, which relieved her pain. One 18-year-old patient was treated successfully for 18 months until his symptoms recurred. The patient refused ulnar shortening, so he underwent a second arthroscopy 19 months after the index procedure. Regeneration of the central TFC portion was also diagnosed in this patient. Repeat resection and debridement again alleviated the patient's complaints.

Among the 16 patients in whom arthroscopy revealed a central TFC perforation, four patients underwent ulnar shortening osteotomy at 3, 4, 8, and 14 months following arthroscopy. Of these patients, three underwent hardware removal at 1, 2, and 3 years following ulnar shortenings. One patient was satisfied with the result of arthroscopy 3 months

postoperatively. However, she suffered a cerebrovascular accident 5 months postoperatively and was therefore excluded from further follow-up.

In both groups of patients, without and with TFC perforations (► **Tables 2 and 3**), at all follow-up examinations, pain on exertion and rest and the Krimmer and DASH scores significantly improved. In patients with TFC perforation, improvement of pronation was significant at 3 and 6 months of follow-up, and improvement of ulnar abduction was significant at all follow-up examinations. In patients without TFC perforation, improvement of grip-strength was significant at 12 months of follow-up, and extension and ulnar abduction significantly improved at the final follow-up. All other variables did not change significantly.

Comparison of the two groups revealed significantly greater improvements of DASH scores at 12 months and final follow-up examinations among patients without TFC perforation. For all other examined variables, there was no significant difference in outcomes between the two groups (► **Table 4**).

Discussion

The study demonstrates that central resection and debridement of the TFC significantly decreases ulnar-sided wrist

Table 3 Results for 16 patients with central TFC perforation following simple central TFC resection and debridement, consecutive ulnar shortening, or hardware removal

	Preop N = 16	3 mo postop N = 16	6 mo postop N = 14	12 mo postop N = 12	Final follow-up mean (1.7 y) N = 15
Pain on exertion (VAS)	7.0 (IQR: 1.3)	4.5 (IQR: 4.9) p = 0.010	2.8 (IQR: 6.8) p = 0.006	2.5 (IQR: 6.9) p = 0.016	1.0 (IQR: 5.0) p = 0.003
Pain on rest (VAS)	1.8 (IQR: 3.6)	0.0 (IQR: 0.8) p = 0.011	0.0 (IQR: 1.4) p = 0.045	0.0 (IQR: 0.0) p = 0.011	0.0 (IQR: 0.0) p = 0.007
Grip-strength compared with contralateral hand	85% (SD: 19)	91% (SD: 14) p = 0.105	92% (SD: 17) p = 0.376	97% (SD: 12) p = 0.206	93% (SD: 10) p = 0.126
Extension (degrees)	60 (IQR: 9)	60 (IQR: 9) p = 0.788	60 (IQR: 13) p = 0.968	70 (IQR: 9) p = 0.119	70 (IQR: 15) p = 0.094
Flexion (degrees)	70 (IQR: 15)	70 (IQR: 14) p = 0.369	65 (IQR: 10) p = 0.580	70 (IQR: 13) p = 0.199	70 (IQR: 20) p = 0.287
Radial abduction (degrees)	30 (IQR: 4)	30 (IQR: 10) p = 0.262	30 (IQR: 8) p = 0.132	33 (IQR: 5) p = 0.331	30 (IQR: 10) p = 0.331
Ulnar abduction (degrees)	23 (IQR: 14)	28 (IQR: 5) p = 0.037	30 (IQR: 5) p = 0.040	30 (IQR: 10) p = 0.017	30 (IQR: 5) p = 0.002
Pronation (degrees)	80 (IQR: 10)	83 (IQR: 18) p = 0.028	90 (IQR: 10) p = 0.013	85 (IQR: 18) p = 0.059	80 (IQR: 20) p = 0.083
Supination (degrees)	90 (IQR: 10)	90 (IQR: 10) p = 1.000	90 (IQR: 10) p = 0.102	90 (IQR: 10) p = 0.317	90 (IQR: 10) p = 0.317
Krimmer score	78.3 (IQR: 18)	85.0 (IQR: 21) p = 0.007	90.8 (IQR: 15) p = 0.020	94.2 (IQR: 19) p = 0.013	100 (IQR: 15) p = 0.002
DASH score	31.0 (IQR: 23)	22.9 (IQR: 28) p = 0.008	15.0 (IQR: 23) p = 0.008	6.3 (IQR: 29) p = 0.002	7.5 (IQR: 27) p = 0.001
Satisfied (Yes/No)	–	13/3	11/3	10/2	13/2

Abbreviations: DASH, disability of arm, shoulder, and hand questionnaire; IQR, interquartile range; SD, standard deviation; TFC, triangular fibrocartilage; VAS, visual analog scale.

Note: Results displayed in median and IQR or in mean and SD.

Table 4 Comparison of outcomes in 16 patients *without* central TFC perforation to 16 patients *with* central perforation

	Outcome compared with index values			
	at 3 mo	at 6 mo	at 12 mo	at final follow-up
Pain on exertion (VAS)				
Without perforation	−3.8 (SD: 2.9)	−4.6 (SD: 2.5)	−4.5 (SD: 2.7)	−5.2 (SD: 2.4)
With perforation	−2.2 (SD: 2.9)	−3.3 (SD: 3.3)	−3.2 (SD: 3.4)	−4.5 (SD: 3.8)
Comparison	$p = 0.104$	$p = 0.226$	$p = 0.270$	$p = 0.564$
Pain on rest (VAS)				
Without perforation	−2.8 (SD: 2.8)	−2.9 (SD: 2.9)	−2.5 (SD: 2.6)	−2.6 (SD: 2.6)
With perforation	−1.3 (SD: 1.7)	−1.4 (SD: 2.5)	−2.1 (SD: 2.1)	−1.6 (SD: 1.7)
Comparison	$p = 0.082$	$p = 0.159$	$p = 0.684$	$p = 0.220$
Grip-strength compared with contralateral hand				
Without perforation	10% (SD: 19)	12% (SD: 24)	15% (SD: 22)	14% (SD: 32)
With perforation	6.4% (SD: 15)	4.4% (SD: 18)	6.3% (SD: 16)	5.7% (SD: 14)
Comparison	$p = 0.551$	$p = 0.344$	$p = 0.252$	$p = 0.354$
Krimmer score				
Without perforation	16 (SD: 16)	18 (SD: 15)	18 (SD: 15)	21 (SD: 14)
With perforation	12 (SD: 13)	14 (SD: 18)	15 (SD: 14)	19 (SD: 14)
Comparison	$p = 0.459$	$p = 0.486$	$p = 0.653$	$p = 0.629$
DASH score				
Without perforation	−26 (SD: 20)	−31 (SD: 19)	−36 (SD: 17)	−36 (SD: 15)
With perforation	−14 (SD: 16)	−20 (SD: 20)	−22 (SD: 14)	−23 (SD: 12)
Comparison	$p = 0.085$	$p = 0.122$	$p = 0.025$	$p = 0.013$
Satisfied with treatment				
Without perforation	13/16	14/15	14/15	15/16
With perforation	13/16	11/14	10/12	13/15
Comparison	$p \geq 0.999$	$p = 0.330$	$p = 0.569$	$p = 0.600$
Consecutive operations				
Without perforation	5 out of 16 (3× ulnar shortening, 1× ulnar shortening, and repeat arthroscopy; 1× repeat arthroscopy)			
With perforation	4 out of 16 (4× ulnar shortening)			
Comparison	$p > 0.999$			

Abbreviations: DASH, disability of arm, shoulder, and hand questionnaire; SD, standard deviation; TFC, triangular fibrocartilage; VAS, visual analog scale. Note: Results displayed in mean and SD.

pain and improves function in patients with ulnar impaction syndrome both with and without TFC perforations. Thereby, ulnar impaction was clinically diagnosed, with these patients presenting with isolated positive fovea signs. Clinical tests were found to have low positive predictive values in the diagnosis of TFC lesions, ranging from 0.53 to 0.55.¹² Accordingly, in this study, TFC perforations were found in half of the patients with clinically diagnosed ulnar impaction syndrome. Diagnoses thereby, deliberately did not rely on MRIs because these demonstrated limited sensitivity and specificity as long as they were not done using a sophisticated technique under study conditions.¹³ If conservative treatment finally fails to alleviate the pain, arthroscopy is commonly accepted as a first-line surgical treatment. In the presence of a central TFC perforation, resection and debride-

ment is performed to decompress the ulnocarpal joint. Thereby, it is irrelevant whether the lesion is of traumatic or degenerative origin.¹ The differentiation between these two etiologies is even more expendable because it is found to be not very reliable.¹⁴ The results, thereby, seem to be favorable in patients with ulna minus or ulnar neutral variance. Instead, high rates of subsequent surgical treatment, such as ulnar shortening osteotomy, can be expected in patients with ulna plus.^{4,15,16}

If a TFC perforation is present, then an arthroscopic wafer procedure may be additionally performed. Del Gaudio and Haerle reported a satisfaction rate of 23 out of 24 treated patients.¹⁷ However, the mean pain on exertion was still as high as 4.5 at a mean follow-up of 13 months. Other authors reported nine excellent and good results in 11 patients who

underwent TFC debridement and arthroscopic wafer resection. Two patients experienced minimal pain, one patient experienced moderate pain, and one patient experienced severe pain after a mean follow-up of 21 months.¹⁸ De Smet et al even reported on only 4 satisfied patients out of 10 after a mean of 25 months following arthroscopic wafer resection.¹⁹ They ascribed these poor results to the learning curve of this procedure. This learning curve implies the potential risk for injury to the DRUJ. Such a complication is rarely reported in the literature.^{20,21} However, injury to the DRUJ may happen more often than reported. Additionally, this complication is a disaster not only for young patients. In our opinion, this procedure is thus correctly critically considered.

If arthroscopy reveals no perforation from the radiocarpal view, the therapeutic options are fewer. Creating a tear to facilitate the wafer procedure is controversial,¹ and performing arthroscopic wafer resection through DRUJ portals is technically demanding and most likely unsafe. However, degenerative changes mostly occur at the proximal surface of the TFC,²² and tears exclusively within the DRUJ are well described.²³ Abe and Tominaga⁷ treated two such patients with an intact TFC from the radiocarpal view but with horizontal tears and fragmentation within the DRUJ. They were able to debride the lesion via DRUJ portals in one patient. In the other patient, this attempt failed, so resection of the TFC was performed from radiocarpal. Both patients recovered to painless function. As a conclusion, Abe and Tominaga recommended DRUJ arthroscopy as adjunct to radiocarpal arthroscopy. However, DRUJ arthroscopy is technically demanding, and visualization of the TFC with its foveal insertion is not constantly achieved.²⁴ Due to these technical difficulties, other authors do not recommend DRUJ arthroscopy as a routine procedure.²⁵ Simple debridement instead of central resection and debridement has shown to be of little value when there is no perforation.¹⁵ Therefore, in this study, we performed ulnocarpal decompression using central resection and debridement. The results were favorable in 12 of the 16 treated patients, with 4 more patients needing ulnar shortening for definitive ulnocarpal unloading.

This study has some limitations. First of all, diagnosis in these patients relies solely on clinical examination, i.e., a positive fovea sign, and a MRI was not performed. Second, the question remains unanswered as to whether central resection is indeed needed to alleviate the patients' symptoms. The question of whether simple TFC debridement within the DRUJ is sufficient cannot be answered by this study. Third, the advantage of resection over simple debridement should be proven by a separate randomized study with enough power from sample sizes that are sufficiently large.

Arthroscopic central TFC resection and debridement sufficiently reduced ulnar-sided wrist pain and improved function in three out of four patients with ulnar impaction syndrome with and without central TFC lesion. As MRI diagnostics is not sufficient in all cases and as arthroscopy is performed anyway in these patients, arthroscopic central TFC resection and debridement qualifies as the first-line treatment of ulnar impaction syndrome. Those patients

who complained of persisting or recurrent ulnar-sided wrist pain finally benefitted from ulnar shortening osteotomy as the secondary procedure.

Note

The ethical committee of the University Hospital of Würzburg, Germany approved the clinical review of these patients.

Conflict of Interest

None.

References

- 1 Sachar J. Ulnar-sided wrist pain: evaluation and treatment of triangular fibrocartilage complex tears, ulnocarpal impactions, and lunotriquetral ligament tears. *J Hand Surg Am* 2012;37(07):1489–1500
- 2 Palmer AK. Triangular fibrocartilage complex lesions: a classification. *J Hand Surg Am* 1989;14(04):594–606
- 3 Löw S, Herold A, Eingartner C. Standard wrist arthroscopy: technique and documentation [in German]. *Oper Orthop Traumatol* 2014;26(06):539–546
- 4 Möldner M, Unglaub F, Hahn P, Müller LP, Bruckner T, Spies CK. Functionality after arthroscopic debridement of central triangular fibrocartilage tears with central perforations. *J Hand Surg Am* 2015;40(02):252–258
- 5 Jang E, Danoff JR, Rajfer RA, Rosenwasser MP. Revision wrist arthroscopy after failed primary arthroscopic treatment. *J Wrist Surg* 2014;3(01):30–36
- 6 Löw S, Spies CK, Unglaub F, van Schoonhoven J, Prommersberger KJ, Mühldorfer-Fodor M. Preventable repeat wrist arthroscopies: Analysis of the indications for 133 cases. *J Wrist Surg* 2017;6(01):33–38
- 7 Abe Y, Tominaga Y. Ulnar-sided wrist pain due to isolated disk tear of triangular fibrocartilage complex within the distal radioulnar joint: two case reports. *Hand Surg* 2011;16(02):177–180
- 8 Kalb K, Ludwig A, Tauscher A, Landsleitner B, Wiemer P, Krimmer H. Treatment outcome after surgical arthrodesis [in German]. *Handchir Mikrochir Plast Chir* 1999;31(04):253–259
- 9 Gelberman RH, Salamon PB, Jurist JM, Posch JL. Ulnar variance in Kienbock's disease. *J Bone Joint Surg Am* 1975;57(05):674–676
- 10 Löw S, Erne H, Schütz A, Eingartner C, Spies CK. The required minimum length of video sequences for obtaining a reliable interobserver diagnosis in wrist arthroscopies. *Arch Orthop Trauma Surg* 2015;35(12):1771–1777
- 11 Löw S, Erne H, Strobl U, Unglaub F, Spies CK. Significance of scapholunate gap width as measured by probe from midcarpal. *J Wrist Surg* 2017;6(04):316–324
- 12 Schmauss D, Pöhlmann S, Lohmeyer JA, Germann G, Bickert B, Megerle K. Clinical tests and magnetic resonance imaging have limited diagnostic value for triangular fibrocartilaginous complex lesions. *Arch Orthop Trauma Surg* 2016;136(06):873–880
- 13 Hahn P, Häusler A, Bruckner T, Unglaub F. Quality rating of MRI regarding TFCC lesions in the clinical practice [in German]. *Handchir Mikrochir Plast Chir* 2012;44(05):310–313
- 14 Löw S, Erne H, Pillukat T, Mühldorfer-Fodor M, Unglaub F, Spies CK. Rating of central lesions of the triangular fibrocartilage complex with respect to a traumatic or degenerative origin. *J Hand Surg Eur Vol* 2017;42(04):357–362
- 15 Nishizuka T, Tatebe M, Hirata H, Shinohara T, Yamamoto M, Iwatsuki K. Simple debridement has little useful value on the clinical course of recalcitrant ulnar wrist pain. *Bone Joint J* 2013; 95(12):1687–1696
- 16 Broccoli G, Vaske B, Müller L, Kahmann R, Isenberg J. Limits to arthroscopic treatment of degenerative triangular fibrocartilage complex lesions depending on the ulnar variance [in German]. *Handchir Mikrochir Plast Chir* 2014;46(03):151–162

- 17 Del Gaudio T, Haerle M. Arthroscopic partial resection of the ulnar head for ulnocarpal decompression [in German]. *Oper Orthop Traumatol* 2016;28(04):263–269
- 18 Bernstein MA, Nagle DJ, Martinez A, Stogin JM Jr, Wiedrich TA. A comparison of combined arthroscopic triangular fibrocartilage complex debridement and arthroscopic wafer distal ulna resection versus arthroscopic triangular fibrocartilage complex debridement and ulnar shortening osteotomy for ulnocarpal abutment syndrome. *Arthroscopy* 2004;20(04):392–401
- 19 De Smet L, De Ferm A, Steenwerckx A, Dauwe D, Zachee B, Fabry G. Arthroscopic treatment of triangular fibrocartilage complex lesions of the wrist. *Acta Orthop Belg* 1996;62(01):8–13
- 20 Constantine KJ, Tomaino MM, Herndon JH, Sotereanos DG. Comparison of ulnar shortening osteotomy and the wafer resection procedure as treatment for ulnar impaction syndrome. *J Hand Surg Am* 2000;25(01):55–60
- 21 Griska A, Feldon P. Wafer resection of the distal ulna. *J Hand Surg Am* 2015;40(11):2283–2288
- 22 Mikić ZD. Age changes in the triangular fibrocartilage of the wrist joint. *J Anat* 1978;126(02):367–384
- 23 Abe Y, Tominaga Y, Yoshida K. Various patterns of traumatic triangular fibrocartilage complex tear. *Hand Surg* 2012;17(02):191–198
- 24 Yamamoto M, Koh S, Tatebe M, et al. Arthroscopic visualisation of the distal radioulnar joint. *Hand Surg* 2008;13(03):133–138
- 25 Pillukat T, Fuhrmann R, Windolf J, van Schoonhoven J. Arthroscopy of the distal radioulnar joint [in German]. *Oper Orthop Traumatol* 2014;26(06):547–555